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## ABSTRACT

Differences between interactive microcomputer and traditional verbal learning groups in a paired-associate learning task were examined in this study. The 88 subjects, who were undergraduate education students, were randomly assigned to four groups. Each group was given one of two lists of ten high frequency words matched with either high or low similarity consonant-vowel-consonant (CVC) trigrams, and subjects were asked to recall the CVC trigrams either by entering responses at the computer (interactive groups) or by responding verbally to the experimenter (traditional groups). The following results were obtained: (1) there was no significant difference between interactive and traditional groups on recall; (2) groups exposed to lists of CVC trigrams of low similarity performed significantly better on recall; (3) no significant difference was found between interactive and traditional groups on number of trials to criterion; (4) the number of trials to criterion was significantly lower for low similarity groups; and (5) there were no significant interactions between similarity and treatment on recall or trials to criterion. Areas for further research are suggested, and statistical tables and a 32-item reference list are attached. (MES)

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Microcomputer Interactive vs. Traditional  
Associative Learning in a Paired-Associative  
Recall Task

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The implementation of microcomputers into the schools has become immediate and widespread (Chambers and Sprecher, 1984). Although industry is ahead of public education in both acceptance and utilization of microcomputers, a survey (Time, 1983) reported that sixty-eight percent of registered voters felt the microcomputer would improve the quality of their children's education. Unlike other educational movements, such as programmed instruction and television, the microcomputer did not evolve from within, but for the most part from business and industry (Bear, 1984).

The field of educational media depends on a theoretical learning base to support applications to instruction and the significant increases in learning due to technology (Saettler, 1979). A key learning theory that is well documented in the literature and supports the contributions of the microcomputer for classroom learning is that of association in verbal learning (Kolesnik, 1976).

Association learning involves stimuli, such as those presented by a teacher, a film, a textbook or a microcomputer and the response to those stimuli by the learner. A common procedure for analyzing verbal associative learning in stimulus-response terms is the method of paired-associates (Deese and Hulse, 1967). With this method, the subject learns pairs of verbal items. When presented with the first member of each pair (the stimulus) the subject must pair the second member (the response). The typical paired-associate learning study uses ten to twelve pairs, such as TIV-GEX or ZPH-HAPPY.

Many examples of paired-associations are representative of the need to learn verbal materials in school settings. In learning math facts, for example, the student must associate the problems ( $7+3=$ ,  $5-2=$ , etc.) with their corresponding answers. In learning to discriminate foreign language words, the learner must associate the foreign word with its English equivalent. Although such tasks are common in elementary school learning, they are perhaps more common in higher education and technological training (Merrill and Salisbury, 1984). Chemistry students must learn the abbreviations of the chemical elements. Medical students learn the names and locations of body parts and piano students learn the position of keys on the keyboard and to associate a particular key with a particular note on the written music. Pairing associations is one way of remembering facts, definitions and formulas when precision is a premium.

Two basic methods of presenting paired-associate lists have been described (Holton and Turnage, 1976). These are referred to as the anticipation method and the recall method. In the anticipation method, the stimulus item is presented alone, followed by presentation of both members of a pair. The task of the subject is to anticipate the response term before the stimulus and response pair are presented together. The recall method of paired-associate learning involves the alternation of study and test trial. During study trials, the entire set of stimulus and

response pairs are presented, but no response is required from the subject. After the list has been presented, the test trial requires that subject recall the responses when supplied with corresponding stimuli. This is generally done to a criterion of X number of perfect trials. Analysis is then done by examining the number of trials to criterion and the number of errors made.

The most common type of media research has been the study that compares a specific medium of instruction against one or more other media, often conventional instruction (Wilkerson, 1980). The microcomputer has not been compared to the traditional approach of paired-associate learning. Traditionally, the use of paired-associate learning has been verbal on the part of the learner. Although the drill and practice mode of paired-associate learning seems hardly innovative just to automate on a microcomputer screen, Hall and Loucks (1978) report that the adoption of an innovation is a process, not an event and should be monitored and evaluated periodically. Each new tool in the teaching field encounters a regimen of testing to see if it offers some measurable benefit to teaching and learning.

Stimulus-response, reinforcement and repetition are conditions necessary to the associative learning process. The capabilities of the microcomputer can address these conditions through simple drill and practice procedures and interaction. Virtually no literature links the microcomputer with traditional paired-associate learning.

Findings on paired-associate learning have found learning under the recall method of presentation to be faster than the anticipation method (Battig and Brackett, 1961; Battig and Wu, 1965; Cofer, Diamond, Olsen, Stein and Walker, 1967; Lockhead, 1962). Studies also concluded that repetition of nonsense syllables and trigrams was beneficial to the learning of paired-associates (Rock, 1957; Postman, 1962) and paired-associate lists with rules seem to be superior to lists of unrelated pairs, especially with lists composed of middle-letter changes pairs (Bower and Bolton, 1969; D'Amato and Diamond, 1979; D'Amato and Rubenstein, 1981). In studies that compared the intralist similarity of the trigrams utilized (Underwood, Runquist and Schultz, 1959; Archer, 1960; Horowitz, 1962) contradictory results were reported. While there is evidence that one can learn from media, little evidence is available concerning which medium promotes the most learning in a given situation (Schramm, 1977).

Every medium provides unique learning capabilities (Bork, 1983). The unique feature of the microcomputer is that of interaction. The microcomputer can be programmed to call for repeated input from users and to respond immediately to that input. This basic performance function is called interaction and is performed via the microcomputer keyboard, which has the standard typewriter keys with additional special functions keys.

Although responses are limited to those programmed into the software, this medium allows the user to actively respond instead of passively learning from presented material.

A typical drill and practice microcomputer strategy is similar to the use of flashcards, an activity often employed in the paired-associate learning process. When the learning of lower level skills is necessary, flashcards provide the learner with stimulus on the front of the card and the correct response on the back of the card. The learner responds to each stimulus, presented sequentially, then refers to the response on the back for corrective feedback and perhaps reinforcement. The learner proceeds through the set of flashcards until all items are learned to a desired criterion level. Similarly, the microcomputer can be programmed to provide a stimulus that elicits a response from the learner. It can repeat the same or very similar question until mastery is achieved. The microcomputer can evaluate responses, provide feedback to the learner and repeat the stimulus-response process indefinitely. Unlike the flashcard technique, the microcomputer can automatically analyze the number of errors made and the number of trials to criterion required for completion.

A search of the literature regarding the instructional use of computer-assisted instruction revealed that for the most part, researchers are optimistic about the future of CAI in education. However, in spite of the great potential of computers in education, evidence of success is not conclusive. There exists a degree of consistency concerning favorable attitudes toward CAI and a saving in student time when using computer-assisted instruction (Hall, 1982; Kulik, Kulik, and Cohen, 1980; Kulik, Bangert and Williams, 1983). Consistent findings have also found that CAI is more effective with elementary students than high school students and more effective with high school students than college populations (Jamison, Suppes and Wells, 1974; Hartley, 1977). The whole matter of achievement remains less clear. Findings of "no significant differences" dominate the research in the area of CAI effectiveness of achievement outcomes. Usually CAI has been found to be at least as effective as other forms of traditional instruction and most effective when integrated with classroom teaching (Edwards, Norton, Taylor, Weiss and Dusseldorf, 1975). Most CAI is used to supplement and complement traditional instruction, not replace it, which makes it extremely difficult to compare CAI and traditional instruction.

The purpose of the study was to investigate differences between interactive microcomputer and traditional verbal learning groups in a paired-associate learning task. Due to the complex nature of examining human learning, the dependent variables in the present study were limited to recall performance. Recall was examined in terms of number of correct responses and number of trials to criterion. Intralist similarity, as the independent variable, was examined in terms of high and low associations using CVC (consonant-vowel-consonant) trigrams. CVC trigrams were used to provide a learning situation. In light of the literature, the

main expectation was that subjects exposed to the microcomputer treatment would perform significantly better than subjects exposed to the traditional method of verbal learning. It was expected that groups exposed to high similarity lists of CVC trigrams would have higher recall scores than the groups exposed to the low intralist similarity trigrams. It was also expected that number of trials to criterion would be the lowest for learning groups exposed to low similarity CVC trigrams than learning groups given the high similarity trigrams.

### Methodology

#### Subjects

The subjects for the study consisted of eighty-eight (88) male and female undergraduate preservice education students at a large midwestern university. The population included volunteers from an educational technology course which is required of all education students desiring teacher certification in the state.

Assignment of subjects to one of four groups was done on a random basis until twenty-two (22) subjects were obtained in each group. Treatment subjects were selected into appropriate groups by typing skill needed to perform interactive functions on a microcomputer keyboard. Once treatment groups were randomly assigned, high or low similarity lists were randomly assigned to each group.

#### Procedure

For the basic paired-associate learning task, a high similarity list of ten pairs and a low similarity list of ten pairs were used. Both lists contained ten high frequency words used in a previous study of Horowitz (1962) and matched with either high or low similarity consonant-vowel-consonant (CVC) trigrams. High and low similarity was established by the frequency of repetition of letters and the number of different letters used in the response trigrams. The high response similarity list was composed of five different letters, two vowels and three consonants. The low similarity list was composed of 23 different letters consisting of all vowels and 17 consonants. The CVC trigrams appearing on both high and low similarity lists were matched according to their association value as determined by Archer (1960). The mean association value for the high similarity list was 65.4 and the mean for the low similarity list was 65.5.

Each subject, regardless of treatment or control, participated on an individual basis to learn the list of paired-associated by the recall method. Group 1 was presented a list of ten pairs of high frequency English words matched with high similarity CVC trigrams via an Apple IIe microcomputer screen. Subjects were asked to recall the CVC trigrams by typing responses on the microcomputer keyboard. Group 2 viewed the same ten high frequency English words, but matched with trigrams of low

intralist similarity. The list of ten matched pairs was also presented by the Apple IIe microcomputer system and responses typed using the microcomputer keyboard. Groups 3 and 4 were control groups and participated in the traditional approach to paired-associate learning, in which the list of matched pairs was projected via 35mm slides and responses were given verbally. Group 3 was asked to recall ten pairs of high frequency English words matched with high similarity CVC trigrams, as was Group 1. However, recall responses were given verbally to the experimenter instead of by typing. Group 4 was presented the same list of English words matched with low similarity trigrams as Group 2. Subjects in Group 4 also responded verbally to the experimenter when recalling CVC trigrams.

### Results

The findings reported for this study are the results of testing the hypotheses that provided the foundation for this study. Group means were tested for significance by using 2x2 analysis of variance. Two separate analyses were conducted on the dependent measures, recall and trials to criterion, as each dependent variable was interesting in and of itself. The independent variables of similarity and treatment were contrasted in both measures. The number of correct responses and trials to criterion were measured on microcomputers (interactive) vs. slides (traditional) and on high and low intralist similarity.

The null hypotheses examined were:

Null Hypothesis 1: There are no significant differences between interactive and traditional treatment groups on verbal recall. The analysis of variance for the interactive and traditional treatments found no significant main effect for the two treatments ( $F=.28, p>.59$ ). There was no significant difference between microcomputer and slides as a treatment on verbal recall. The null hypothesis was retained (see Table 1).

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Table 1 goes about here

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Table 2 presents the means obtained for recall of CVC trigrams. As the table indicates, the mean number of correctly recalled CVC trigrams was greater for the traditional group than for the interactive group ( $X=59.01$  and  $56.14$  respectively). However, statistically they were not significant.

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Table 2 goes about here

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Null Hypothesis 2: There are no significant differences between groups exposed to high similarity lists and groups exposed to low similarity lists on verbal recall. As indicated in Table 1, the similarity dimension was a significant source of variance ( $F=5.84$ ,  $p<0.01$ ). The mean scores for high and low similarity ( $\bar{X}=63.66$  and  $51.79$  respectively) are shown on Table 2. The groups exposed to lists of CVC trigrams of low similarity performed significantly better on verbal recall. The null hypothesis was rejected.

Null Hypothesis 3: There are no significant differences in interactive vs. traditional groups in total number of trials to criterion. There was no significant main effect for interactive and traditional treatment groups ( $F=0.21$ ,  $p>0.64$ ) in total number of trials to criterion (see Table 3).

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Table 3 goes about here

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The mean scores for interactive vs. traditional groups ( $\bar{X}=7.93$  and  $8.33$ , respectively) confirm that there was no significant difference between the two groups in the total number of trials to criterion (see Table 4). The null hypothesis was retained.

Null Hypothesis 4: There are no significant differences between groups exposed to high similarity lists and groups exposed to low similarity lists on total number of trials to criterion.

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Table 4 goes about here

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The analysis of variance found a significant main effect for similarity on total number of trials to criterion ( $F=5.79$ ,  $p<0.018$ ). Table 4 indicates the mean score of  $7.21$  for low similarity groups is significantly lower than the mean score of  $9.10$  for high similarity groups. The null hypothesis was rejected.

Null Hypothesis 5: There are no significant interactions between groups on similarity and treatment on verbal recall. The two-way interaction between similarity and treatment on recall was not significant ( $F=0.24$ ,  $p>0.62$ ). The null hypothesis was retained.

Null Hypothesis 6: There are no significant interactions between groups on similarity and treatment on total number of trials to criterion. The two-way interaction between similarity and treatment on total number of trials to criterion was not significant ( $F=0.208$ ,  $p>0.649$ ). The null hypothesis was retained.

## Conclusions

Data were analyzed to test for two main effects to determine whether or not there was a significant difference in recall and number of trials to criterion on the independent variables of high and low similarity and interactive and traditional treatment groups.

The following conclusions may be drawn from the results of the data:

1. It was found that subjects exposed to a list of CVC trigrams of low intralist similarity performed significantly better on verbal recall than subjects exposed to a list of high intralist similarity CVC trigrams. Also, the number of trials to criterion was found to be significantly less for the low CVC similarity groups than for the high CVC similarity groups.
2. It was found that neither microcomputer (interactive) nor slides (traditional) showed significantly better results as a treatment on verbal recall and number of trials to criterion in a paired-associate learning task.

## Findings and Discussion

The similarity dimension was a significant source of variance in this study. The mean scores for high and low similarity show that treatment groups exposed to a list of CVC trigrams of low similarity performed significantly better on verbal recall. Low intralist similarity groups also took fewer trials to reach criterion than high similarity groups.

This finding adds support to the previous research of Horowitz (1962) who concluded that high intralist similarity hinders associative learning. This study also adds to the data base in the area of intralist similarity in paired-associate learning, which to date has had contradictory research findings.

It is possible that mnemonics played an important role in learning the list of paired-associates. The high intralist CVC trigrams were so closely matched with only three consonants and two vowels that recall was more difficult even with the use of mnemonic techniques.

Subjects in this study experienced either traditional or interactive techniques of paired-associate learning as treatment. An analysis of variance indicated that there were no significant differences between microcomputer and slides as a treatment on verbal recall and number of trials to criterion when tested at the .05 level of significance.

It should be recognized that all groups were able to learn equally well. No group suffered because of method of treatment to which they were subjected. Even though the difference between microcomputer interaction and traditional treatment groups is not large enough in relation to the validity of the data to be significant, the microcomputer treatment groups performed slightly better than the traditional treatment groups on both verbal recall and number of trials to criterion measures.

A practical value for educators can be found in these results, even if non-significant. Consistent findings of non-significant differences in learning from different instructional mediums provide alternative methods of instruction for the educator. Research has shown that no single medium is superior in all aspects in any instructional situation. It is also apparent that any medium can make a viable contribution to almost any learning task. Schramm (1977) in his review of media research literature concluded that:

Motivated students learn from any medium if it is competently used and adapted to their needs. Within its physical limits, any medium can perform an adequate task. Whether a student learns more from one medium than from another is at least as likely to depend on how the medium is used as on what medium is used. (Schramm, p. iv.)

Another possible explanation for the non-significant finding may be that media and learning are not related to the extent anticipated. If a distinction is made among media, messages, and methods, a medium is merely the vehicle for the information and not the information itself. Therefore, any effect on learning achievement would have to be a result of the message and not the medium.

Computer-assisted instruction can be an effective educational tool under the proper conditions. However, embarrassment, content limitations, feedback, reinforcement and learning styles need to be variables considered in the classroom application of microcomputers and paired-associate verbal learning. Requiring all students to use computer-assisted instruction may not be in the best interests of the student. The matching of the teaching style to a specific computer program and the learning style of the student must be considered.

The research study revealed several areas for further study with microcomputers. First, more studies need to be conducted with the college level population. To date, very few computer-assisted instruction studies have measured achievement of college students on microcomputers. Large mainframe computer studies dominate the literature at this educational level.

A second recommendation is that researchers examine mnemonic techniques as a strategy to help students learn. With the capabilities of graphics, animation, keyboard interaction, color

and branching provided by the microcomputer, mnemonics could be programmed into computer-assisted instruction to prompt the subject.

Finally, future studies should incorporate educational theories into the design of computer-assisted instruction. More meaningful content and meaningful applications should be implemented with microcomputers in place of fragmented recall-based lessons. The capabilities of self-pacing, branching, reinforcement and repetition provided by the microcomputer can be utilized in designing computer-assisted instruction with meaningful information in all content areas.

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Table 1  
Analysis of Variance Summary Table  
Using Recall of Trigrams

| Source of Variance  | Sum of Squares | df | Mean Square | F-Ratio |
|---------------------|----------------|----|-------------|---------|
| Similarity          | 2923.64        | 1  | 2923.64     | 5.84*   |
| Medium              | 141.86         | 1  | 141.86      | 0.28    |
| Similarity X Medium | 123.62         | 1  | 123.62      | 0.24    |
| Residual            | 40048.84       | 80 | 500.61      | XXX     |
| Total               | 43270.71       | 83 | 521.33      | XXX     |

\*p<.05

Table 2  
Means for Recall of CVC Trigrams

|                             | High CVC<br>Similarity          | Low CVC<br>Similarity           | Raw Total         |
|-----------------------------|---------------------------------|---------------------------------|-------------------|
| Treatment<br>Microcomputers | $\bar{X} = 63.60$<br>SD = 21.93 | $\bar{X} = 49.36$<br>SD = 19.58 | $\bar{X} = 56.14$ |
| Treatment<br>35mm Slides    | $\bar{X} = 63.71$<br>SD = 30.21 | $\bar{X} = 54.33$<br>SD = 15.17 | $\bar{X} = 59.02$ |
| Column Total                | $\bar{X} = 63.66$<br>SD = 26.17 | $\bar{X} = 51.79$<br>SD = 17.54 |                   |

Table 3  
Analysis of Variance Summary Table  
Using Number of Trials to Criterion

| Source of Variance     | Sum of Squares | df | Mean Square | F-Ratio |
|------------------------|----------------|----|-------------|---------|
| Similarity             | 74.11          | 1  | 74.11       | 5.79*   |
| Medium                 | 2.72           | 1  | 2.72        | 0.21    |
| Similarity X<br>Medium | 2.66           | 1  | 2.66        | 0.20    |
| Residual               | 1023.34        | 80 | 12.79       | XXX     |
| Total                  | 1103.56        | 83 | 13.29       | XXX     |

\*p<.05

Table 4  
Means for Number of Trials to Criterion

|                             | High CVC<br>Similarity        | Low CVC<br>Similarity         | Raw Total        |
|-----------------------------|-------------------------------|-------------------------------|------------------|
| Treatment<br>Microcomputers | $\bar{X} = 9.10$<br>SD = 3.61 | $\bar{X} = 6.86$<br>SD = 3.30 | $\bar{X} = 7.93$ |
| Treatment<br>35mm Slides    | $\bar{X} = 9.10$<br>SD = 4.58 | $\bar{X} = 7.57$<br>SD = 2.52 | $\bar{X} = 8.33$ |
| Column Total                | $\bar{X} = 9.10$<br>SD = 4.09 | $\bar{X} = 7.21$<br>SD = 2.93 |                  |